

WHAT IS CLAIMED IS:

1. A radio receiver for receiving a selected digital HDTV signal, irrespective of whether it is a quadrature-amplitude-modulation (QAM) or a vestigial-sideband (VSB) signal, comprising:

5 a tuner for selecting said selected digital HDTV signal, irrespective of whether it is a complex-amplitude-modulation (QAM) or a vestigial sideband (VSB) signal, and converting it to a final intermediate-frequency (IF) signal;

an analog-to-digital converter for digitizing said final IF signal to generate a digitized final IF signal;

10 QAM synchrodyning circuitry for generating real and imaginary sample streams of interleaved QAM symbol code, by synchrodyning said digitized final IF signal to baseband providing it is a QAM signal and otherwise processing said digitized final IF signal as if it were a QAM signal to be synchrodynd to baseband; and

15 VSB synchrodyning circuitry for generating a real sample stream of interleaved VSB symbol code, by synchrodyning said digitized final IF signal to baseband providing it is a VSB signal and otherwise processing said digitized final IF signal as if it were a VSB signal to be synchrodynd to baseband.

2. A radio receiver as set forth in Claim 1, further comprising:

5 means for detecting whether said final IF signal is a QAM signal or a VSB signal to generate a control signal, said control signal being in a first condition when said final IF signal is a QAM signal and being in a second condition when said final IF signal is a VSB signal;

means responding to said control signal being in a first condition for automatically switching the radio receiver to operate in a QAM signal reception mode; and

means responding to said control signal being in a second condition for
10 automatically switching the radio receiver to operate in a VSB signal reception
mode.

3. A radio receiver as set forth in Claim 2 wherein said means for detecting
whether said final IF signal is a QAM signal or a VSB signal comprises:

a pilot carrier presence detector for generating said control signal, said pilot
carrier presence detector generating said first condition of said control signal when
5 detecting the presence of a pilot carrier of substantial energy and otherwise
generating said second condition of said control signal.

4. A radio receiver as set forth in Claim 3, wherein said tuner includes first and
second intermediate-frequency amplifiers, said radio receiver further comprising:

a digital-to-analog converter for converting to an analog output signal
therefrom, a digital input signal supplied thereto;

5 means for controlling the gains of said first and second
intermediate-frequency amplifiers in accordance with said analog output signal
from said digital-to-analog converter;

means for squaring each of the samples in one of real and imaginary sample
streams of interleaved QAM symbol code;

10 a first lowpass digital filter for obtaining the mean average of the resulting
squared samples;

means for determining the departure from a first prescribed value, of said
mean average of said resulting squared samples, thereby to generate a first digital
AGC signal;

15 a second lowpass digital filter for obtaining the mean average of the samples
in said real sample stream of interleaved VSB symbol code, said second lowpass
digital filter being included in said pilot carrier presence detector;

means for determining the departure from a second prescribed value, of said mean average of said samples in said real sample stream of interleaved VSB symbol code, thereby to generate a second digital AGC signal;

a multiplexer, said multiplexer responding to indications generated by said pilot carrier presence detector that said selected HDTV signal is of QAM type for selecting said first digital AGC signal as the digital input signal supplied to said digital-to-analog converter, said multiplexer responding to indications generated by said pilot carrier presence detector that said selected HDTV signal is of VSB type for selecting said second digital AGC signal as the digital input signal supplied to said digital-to-analog converter; and

means, included in said pilot carrier presence detector, for determining the departure from a third prescribed value, of said mean average of said samples in said real sample stream of interleaved VSB symbol code, the polarity of said departure from a third prescribed value indicating whether said pilot carrier presence detector indicates the presence or absence of pilot carrier accompanying said selected HDTV signal.

5. A radio receiver as set forth in Claim 1, wherein said tuner includes first and second intermediate-frequency amplifiers, said radio receiver further comprising:

a digital-to-analog converter for converting to an analog output signal therefrom, a digital input signal supplied thereto;

means for controlling the gains of said first and second intermediate-frequency amplifiers in accordance with said analog output signal from said digital-to-analog converter;

means for squaring each of the samples in one of real and imaginary sample streams of interleaved QAM symbol code;

a first lowpass digital filter for obtaining the mean average of the resulting squared samples;

means for determining the departure from a first prescribed value, of said mean average of said resulting squared samples, thereby to generate a first digital AGC signal;

15 a second lowpass digital filter for obtaining the mean average of the samples in said real sample stream of interleaved VSB symbol code;

means for determining the departure from a second prescribed value, of said mean average of said samples in said real sample stream of interleaved VSB symbol code, thereby to generate a second digital AGC signal; and

20 a multiplexer, said multiplexer responding to said control signal being in a first condition for selecting said first digital AGC signal as the digital input signal supplied to said digital-to-analog converter, said multiplexer responding to said control signal being in a second condition for selecting said second digital AGC signal as the digital input signal supplied to said digital-to-analog converter.

6. A radio receiver as set forth in Claim 1, further comprising:

QAM symbol de-interleaving means responsive to said real and imaginary sample streams of interleaved QAM symbol code for generating real and imaginary sample streams of de-interleaved QAM symbol code;

5 VSB symbol de-interleaving means responsive to said real sample stream of interleaved VSB symbol code for generating a real sample stream of de-interleaved VSB symbol code;

means for detecting whether said final IF signal is a QAM signal or a VSB signal to generate a control signal, said control signal being in a first condition when said final IF signal is a QAM signal and being in a second condition when said final IF signal is a VSB signal;

10 an amplitude-and-group-delay equalizer having real-sample and imaginary-sample input terminals, real-sample and imaginary-sample output terminals, a programmable digital filter for processing digital signal received at the

15 input terminals of said equalizer to supply amplitude-equalized response at the
real-sample and imaginary-sample output terminals of said equalizer, and
computing elements for programming said digital filter in accordance with said
control signal and with selected portions of the digital signal received at the input
terminals of said equalizer; and

20 a synchrodyne result selector, responsive to the first condition of said
control signal for selecting said real sample stream of de-interleaved QAM symbol
code for application to the real-sample input terminal of said equalizer, further
responsive to the first condition of said control signal for selecting said imaginary
sample stream of de-interleaved QAM symbol code for application to the
25 imaginary-sample input terminal of said equalizer, responsive to the second
condition of said control signal for selecting said real sample stream of
de-interleaved VSB symbol code for application to the real-sample input terminal of
said equalizer, and further responsive to the second condition of said control signal
for selecting arithmetic zero to the imaginary-sample input terminal of said
30 equalizer.

7. A radio receiver as set forth in Claim 6, wherein said means for detecting
whether said final IF signal is a QAM signal or a VSB signal comprises:

a pilot carrier presence detector detecting the presence or absence of a pilot
carrier accompanying said selected HDTV signal for generating said control signal.

8. A radio receiver as set forth in Claim 6, wherein said VSB symbol
de-interleaving means comprises, at least at selected times, an NTSC-rejection
filter.

9. A radio receiver as set forth in Claim 6, including 2:1 decimation circuitry,
for decimating 2:1 said samples applied to the real-sample input terminal of said

equalizer, and for decimating 2:1 said samples applied to the imaginary-sample input terminal of said equalizer.

10. A radio receiver as set forth in Claim 1, further comprising:

QAM symbol de-interleaving means responsive to said real and imaginary sample streams of interleaved QAM symbol code for generating real and imaginary sample streams of de-interleaved QAM symbol code;

5 an NTSC-rejection filter responsive to said real sample stream of interleaved VSB symbol code for generating an NTSC-rejection filter response;

means for detecting whether said final IF signal is a QAM signal or a VSB signal to generate a control signal, said control signal being in a first condition when said final IF signal is a QAM signal and being in a second condition when said
10 final IF signal is a VSB signal;

an amplitude-and-group-delay equalizer having real-sample and imaginary-sample input terminals, real-sample and imaginary-sample output terminals, a programmable digital filter for processing digital signal received at the input terminals of said equalizer to supply amplitude-equalized response at the
15 real-sample and imaginary-sample output terminals of said equalizer, and computing elements for programming said digital filter in accordance with said control signal and with selected portions of the digital signal received at the input terminals of said equalizer; and

20 a synchrodyne result selector, responsive to the first condition of said control signal for selecting said real sample stream of de-interleaved QAM symbol code for application to the real-sample input terminal of said equalizer, further responsive to the first condition of said control signal for selecting said imaginary sample stream of de-interleaved QAM symbol code for application to the imaginary-sample input terminal of said equalizer, responsive to the second
25 condition of said control signal for selecting said for application to the real-sample

input terminal of said equalizer, and further responsive to the second condition of said control signal for selecting arithmetic zero to the imaginary-sample input terminal of said equalizer.

11. A radio receiver as set forth in Claim 10, wherein said means for detecting whether said final IF signal is a QAM signal or a VSB signal comprises:

a pilot carrier presence detector detecting the presence or absence of a pilot carrier accompanying said selected HDTV signal for generating said control signal.

12. A radio receiver as set forth in Claim 10, including 2:1 decimation circuitry, for subsampling 2:1 said samples applied to the real-sample input terminal of said equalizer, and for subsampling 2:1 said samples applied to the imaginary-sample input terminal of said equalizer.

13. A radio receiver as set forth in Claim 10, further comprising:

a two-dimensional trellis decoder for performing symbol decoding that recovers a digital data stream from the amplitude-equalized response of said equalizer when said final IF signal is a QAM signal;

first data synchronization recovery circuitry for recovering first data synchronizing information included in the digital data stream from the two-dimensional trellis decoder;

a one-dimensional trellis decoder for performing symbol decoding that recovers a digital data stream from the amplitude-equalized response of said equalizer when said final IF signal is a VSB signal;

second data synchronization recovery circuitry for recovering second data synchronizing information included in the digital data stream from the one-dimensional trellis decoder;

5 15 a data source selector, responsive to the first condition of said control signal for selecting as its output signal the digital data stream from said two-dimensional trellis decoder, and responsive to the second condition of said control signal for selecting as its output signal the digital data stream from said one-dimensional trellis decoder; and

20 a data sync selector, responsive to the first condition of said control signal for selecting as its output signal said first data synchronizing information, and responsive to the second condition of said control signal for selecting as its output signal said second data synchronizing information.

14. A radio receiver as set forth in Claim 13, further comprising:

5 30 a data de-interleaver receiving the output signals of said data source selector and said data sync selector as input signals thereto, said data de-interleaver de-interleaving the output signal of said data source selector in one of two patterns, as selected by said control signal, for supplying de-interleaved data as its output signal.

15. A radio receiver as set forth in Claim 14, further comprising:

5 35 a Reed-Solomon decoder receiving the output signals of said data de-interleaver and said data sync selector as input signals thereto, said Reed-Solomon decoder decoding the output signal of said data de-interleaver in accordance with one of two Reed-Solomon decoding algorithms, as selected by said control signal, for supplying error-corrected data as its output signal.

16. A radio receiver as set forth in Claim 15, further comprising:

5 a data de-randomizer, connected for receiving said error-corrected data from said Reed-Solomon decoder and said data sync selector as input signals thereto, and connected for supplying de-randomized error-corrected data as an output

signal therefrom.

17. A radio receiver as set forth in Claim 16, for receiving a selected digital HDTV signal of a type causing said de-randomized error-corrected data to be arranged in packets, said radio receiver further comprising:

a digital sound decoder;

an MPEG video decoder; and

a packet sorter receiving as its input signal the output signal of said data de-randomizer and sorting said packets of said de-randomized error-corrected data therein, for applying certain ones of said packets to said digital sound decoder as input signal thereto, and for applying certain ones of said packets to said MPEG video decoder as input signal thereto.

18. A radio receiver as set forth in Claim 1, wherein said final IF signal resides in a frequency band the lowest frequency of which is not appreciably more than 2.38 MHz, which frequency band is substantially 6 MHz wide.

19. A radio receiver for receiving a selected one of high-definition television (HDTV) signals each including symbol codes descriptive of digital signals, irrespective of whether said selected HDTV signal is a quadrature-amplitude-modulation (QAM) signal or is a vestigial- sideband (VSB) signal including a pilot carrier having an amplitude related to signal levels in said symbol codes thereof, said radio receiver comprising:

a tuner, including

means for selecting one of channels at different locations in a frequency band used for transmitting HDTV signals, including

a succession of mixers for performing a plural conversion of signal received in the selected channel to a final intermediate-frequency (IF) signal, including

a respective frequency-selective amplifier between each earlier one of said mixers in said succession and each next one of said mixers in said succession, and including

15 respective local oscillators for supplying oscillations of different frequencies to each of said mixers, each of said local oscillators supplying respective oscillations of substantially the same frequency irrespective of whether the selected HDTV signal is a QAM signal or is a VSB signal;

20 a sample clock generator for generating a sample clock signal comprising recurrent pulses supplied at a rate controlled to be a multiple of the symbol frequency of said selected HDTV signal;

25 an analog-to-digital converter responsive to said sample clock signal for recurrently sampling a lowpass response to the signal from the final mixer in said succession of mixers included in said tuner, and for digitizing the resulting samples to generate a digitized final intermediate frequency signal;

 means for modularly counting said recurrent pulses to generate a first address count;

 means combining a first symbol phase correction with said first address count for generating first read-only memory addressing;

30 first read-only memory addressed by said first read-only memory addressing for generating digital descriptions of in-phase and quadrature-phase QAM signal carriers;

 means for modularly counting said recurrent pulses to generate a second address count;

35 means combining a second symbol phase correction with said second address count for generating second read-only memory addressing;

 second read-only memory addressed by said second read-only memory addressing for generating digital descriptions of in-phase and quadrature-phase VSB signal carriers;

40 first and second synchrodyning means each using said digital descriptions of
in-phase and quadrature-phase QAM signal carriers for generating first and second
synchrodyning results, respectively, in which said first and second synchrodyning
results real and in-phase components of said digitized final intermediate frequency
signal are respectively synchrodynded each to baseband whenever said selected
45 HDTV signal is a QAM signal;

a first symbol decoder for decoding said symbol codes, as encoded in said
first and second synchrodyning results whenever said selected HDTV signal is a
QAM signal, for generating a first data stream;

50 a first phase correction generator for generating said first symbol phase
correction responsive to said first and second synchrodyning results;

55 third synchrodyning means using said digital descriptions of in-phase and
quadrature-phase VSB signal carriers for generating a third synchrodyning result, in
which said third synchrodyning result a real component of said digitized final
intermediate frequency signal is synchrodynded to baseband whenever said selected
HDTV signal is a VSB signal;

a second symbol decoder for decoding said symbol codes, as encoded in
said third synchrodyning result whenever said selected HDTV signal is a VSB
signal, for generating a second data stream;

60 a second phase correction generator for generating said second symbol
phase correction responsive to said third synchrodyning result;

means for detecting whether said final IF signal is a QAM signal or a VSB
signal to generate a control signal, said control signal being in a first condition
when said final IF signal is a QAM signal and being in a second condition when said
final IF signal is a VSB signal;

65 means responding to said control signal being in a first condition for
automatically switching the radio receiver to operate in a QAM signal reception
mode; and

means responding to said control signal being in a second condition for automatically switching the radio receiver to operate in a VSB signal reception mode.

20. A radio receiver as set forth in Claim 19, wherein said means for detecting whether said final IF signal is a QAM signal or a VSB signal comprises:

a pilot carrier presence detector detecting the presence or absence of a pilot carrier accompanying said selected HDTV signal for generating said control signal.

21. A radio receiver as set forth in Claim 19, further comprising:

a generator of first automatic frequency control signal, which first frequency control signal is generated in response to said first and second synchrodyning results;

means for selectively applying said first automatic frequency control signal to an automatic-frequency-controlled one of said local oscillators in said tuner whenever said control signal is in its said first condition, thereby regulating the frequency of the signal from said final mixer so said first and second synchrodyning results are at baseband, which means for selectively applying said first automatic frequency control signal is included in said means responding to said control signal being in a first condition for automatically switching the radio receiver to operate in a QAM signal reception mode;

fourth synchrodyning means using said digital descriptions of in-phase and quadrature-phase VSB signal carriers for generating a fourth synchrodyning result, in which said fourth synchrodyning result an imaginary component of said digitized final intermediate frequency signal is synchrodynd to baseband whenever said selected HDTV signal is a VSB signal;

a generator of second automatic frequency control signal, which second frequency control signal is generated in response to said fourth synchrodyning

20 result; and

means for selectively applying said second automatic frequency control signal to said automatic-frequency-controlled one of said local oscillators in said tuner whenever said control signal is in its said second condition, thereby regulating the frequency of the signal from said final mixer so said third and fourth synchrodyning results are at baseband, which means for selectively applying said second automatic frequency control signal is included in said means responding to said control signal being in a second condition for automatically switching the radio receiver to operate in a VSB signal reception mode.

22. A radio receiver for receiving a selected one of high-definition television (HDTV) signals each including symbol codes descriptive of digital signals, irrespective of whether said selected HDTV signal is a quadrature-amplitude-modulation (QAM) signal or is a vestigial- sideband (VSB) signal including a pilot carrier having an amplitude related to signal levels in said symbol codes thereof, said radio receiver comprising:

a pilot carrier presence detector detecting the presence or absence of a pilot carrier accompanying said selected HDTV signal for generating indications of whether said selected HDTV signal is of VSB or QAM type;

means responding to indications generated by said pilot carrier presence detector that said selected HDTV signal is of VSB type for automatically switching the radio receiver for operation in a VSB signal reception mode; and

means responding to indications generated by said pilot carrier presence detector that said selected HDTV signal is of QAM type for automatically switching the radio receiver for operation in a QAM signal reception mode.

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